1. Использование дорогостоящего оборудования

2. Выполнение несвойственной работы операторами станка

3. Чувствительность к толщине защитного покрытия

4. Выполнение операторами фрезерных станков несвойственной им работы

ОДНАКО УКАЗАННЫЕ НЕДОСТАТКИ НЕ МОГУТ СНИЗИТЬ ОСНОВНОЕ ДОСТОИНСТВО МЕТОДА – ГАРАНТИРОВАННОЕ ОТСУТСТВИЕ ПОВРЕЖДЕНИЙ ПОВЕРХНОСТИ. ГОДОВОЙ ЭКОНОМИЧЕСКИЙ ЭФФЕКТ ПРИ ПЛАНИРУЕМЫХ ОБЪЕМАХ ПРОИЗВОДСТВА ПРЕВЫШАЕТ 3 МЛН. РУБЛЕЙ.

LIFT OF THE NOSE DROOP AIRFOIL

© 2012 Vladimir A. Frolov[1], YANG Hao[2]

1 – SamaraStateAerospaceUniversity (NationalResearchUniversity), Russian Federation, Samara
2 – Beijing Institute of Technology, People's Republic of China, Beijing

A model for the potential circulation flow around nose droop airfoil has been proposed. The solution is obtained for the flow of incompressible ideal fluid. The Complex Variable Function Theory, Method of Discrete Vortices(MDV) and numerical-analytical method (NAM)are applied. Dependence of the lift on the angle of attack, relative length of the nose droop and its angle of deflection is obtained.

The main goal of the paper is modeling the airfoil by NAM and MDV to give the dependences which give the relationships between the lift coefficient and the angle of attack at different deflected angle of nose. The most important result in the paper is the correction of Torenbeek's function [1] of the nose droop airfoil.

The geometry of the airfoil is constructed as the Fig.1 showed. The nose part is a life part of a ellipse, the equation (1) is the equation of the ellipse

$$\frac{x^2}{x_c^2}+\frac{y^2}{(c/2)^2}=1 .(1)$$

The tail is made up by two arcs of circle as Fig.1 showed. The radius of the arc is R.

$$R=\frac{(b-x_c)^2+(c/2)^2}{c} \quad (2)$$

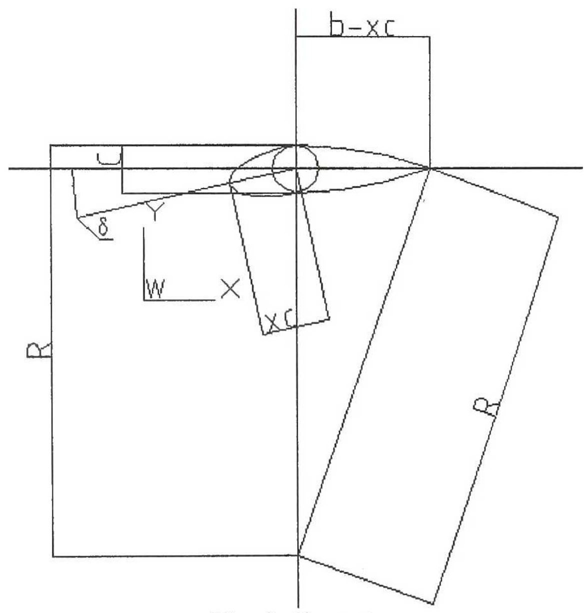

Fig. 1: Geometry

The center of the airfoil is a circle, the radius of the circle is c/2. δ is the deflect angle of the nose.

Then the boundary elements must be constructed. The boundary element points have divided the airfoil into many equal arcs. One control point and one vortex are located around one boundary element as the Fig.2 showed.

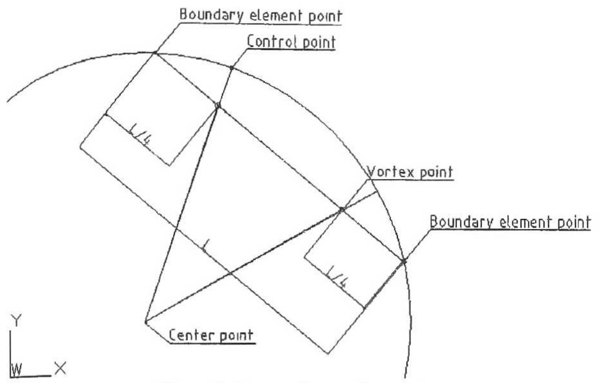

Fig. 2: Boundary element

The distance between two boundary element points is L. The vortex is located at the L/4. And the control point is located on the arc as showed in the Fig.2. The symmetric boundary element configuration is adopted at the tail part as showed in Fig.3. The second difference is that a small part of the center circle without boundary elements as showed in the Fig.3. The grey points are boundary element points, the green points are vortex points and the purple points are the control points. Then all the boundary elements make a vortex point and control point as the Fig.3 showed. Till now the construction of the boundary elements, vortex points and control points is finished.

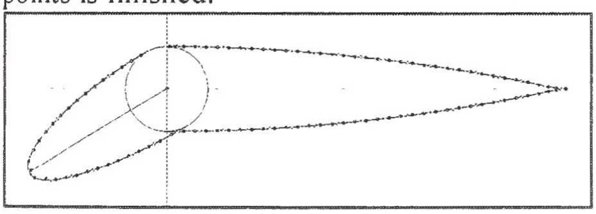

Fig. 3: All points

The method to realize the Kutta condition is to add a couple of control and vortex in the flow field. The vortex point is located at the center of the circle; the control is located at the point which is near the tail point as showed in Fig.4. The distance between the tail point and the Kutta condition control point is 1/4 length of a boundary element.

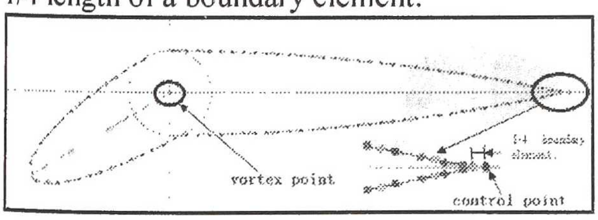

Fig. 4: Kutta points

The next step is adding the stream function as equation (3).

$$W(z)=\bar{V}_{\infty}z+V_{\infty}\frac{a^2}{z}+ \qquad (3)$$

$$+\frac{1}{2\pi i}\left\{\sum_{j=1}^{N}\Gamma_j\left[\ln\frac{\left(z-z_{vj}\right)z}{\left(z-\dfrac{a^2}{\bar{z}_{vj}}\right)}+\Gamma_{N+1}\ln z\right]\right\}$$

where a–radius of the center circle; $\bar{z}_{vj}$ – conjugate complex of z_{vj}.

The velocity can be calculated by the equation(4).

$$u=\mathrm{Re}\left[\frac{dW}{dz}\right];\quad v=-\mathrm{Im}\left[\frac{dW}{dz}\right] \qquad \textbf{(4)}$$

Thus we can get the matrix of stream function. When the matrix is solved by the Gauss-Jordan method, any point's velocity in the flow field can be solved. The streamlines can be constructed as Fig. 5showed.

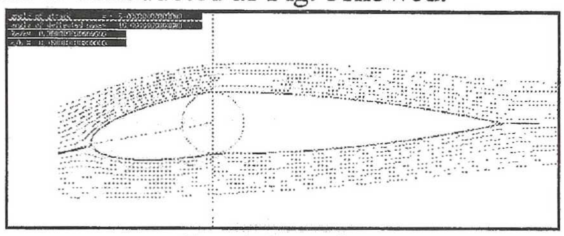

Fig. 5: Streamlines

The lift coefficientis determinedby the formula

$$C_L=f\left(\bar{x}_c,\bar{c},\alpha,\delta\right)=-\frac{2\Gamma}{V_\infty b} \qquad (5)$$

$$\Gamma=\sum_{j=1}^{N}\Gamma_j \qquad (6)$$

where $\bar{x}_c=x_c/b$, $\bar{c}=c/b$, α – angle of attack, δ – angle of deflection.

In the engineer book written by the TorenbeekE., the author gave the theory(when $\bar{c}\approx 0$) that the using of nose flap leads to a decrease in lift at zero angle of attack, which can be calculated by using the Glauert formula for the linear theory:

$$\Delta_{nose\,droop}C_y(0)=-\tau\cdot\delta_{nose}\cdot C_y^{\alpha} \quad (7)$$

$$C_y^{\alpha}=\frac{dC_y}{d\alpha},\ \tau=\frac{\theta_{nose}-\sin\theta_{nose}}{\pi},\ \theta_{nose}=\arccos\left(1-2\frac{b_{nose}}{b}\right).$$

$$\tau_{calc}=-\frac{\Delta_{nosedroop}C_y(0)}{\delta_{nd}C_y^{\alpha}} \qquad \textbf{(8)}$$

The right part of the equation (8) must be the results calculated by the program, then the left part of the equation (8) can be use for further using of Torenbeek's method. Result shown in Fig.6 can be to recommend for engineers' further research.

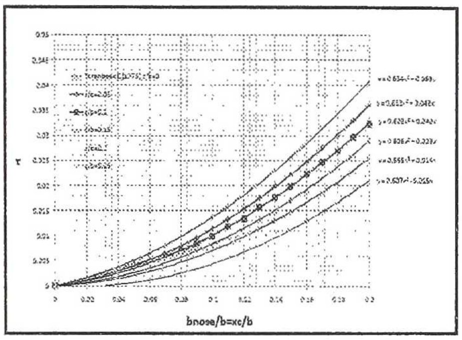

Fig. 6: $\tau_{calc} = f\left(\overline{b}_{nose}, \overline{c}\right)$

REFERENCES

1. Torenbeek, Egbert. Synthesis of Subsonic Airplane Design –Netherlands: DelftUniversity Press, 1982. – 547 p.

РАЗРАБОТКА И ИЗГОТОВЛЕНИЕ ДРЕНАЖНОЙ МОДЕЛИ МЕХАНИЗИРОВАННОГО ПРОФИЛЯ С ПОМОЩЬЮ 3D-ПРИНТЕРА

© 2012 Фролов В.А., Хоробрых М.А.

Самарский государственный аэрокосмический университет имени академика С.П. Королёва (национальный исследовательский университет), Самара

DEVELOPMENT AND PRODUCTION OF PRESSURE-PLOTING MODEL OF THE MECHANIZED AIRFOIL WITH 3D-PRINTER

© 2012 Frolov V.A., Khorobrykh M.A.

This paper is devoted designing of an airfoil with mechanization in SolidWorks CAD software and their productions by means of the 3D-printer are considered. The first time the technology of 3D-printing is applied for production of pressure-plotting model of the mechanized airfoil. This method of making of the models is more rapid, precise and relatively inexpensive.

До недавнего времени процесс проектирования и изготовления аэродинамических моделей занимал до нескольких недель, а порой и месяцев. Процесс изготовления аэродинамических моделей во многом совпадает с более общим процессом, имеющим место в промышленности, который имеет название «прототипирование». Процесс прототипирования это создание объектов по их компьютерной 3D-модели. Сфера разработки и изготовления макетов находится в постоянном развитии, что способствует появлению новых инструментов и приёмов.

Пожалуй, самым ярким примером такого развития является технология быстрого прототипирования (Rapid Prototyping) или как её ещё называют – 3D-печать.С помощью 3D-принтеров можно в кратчайшие сроки создать образцы практически любых объектов, в том числе макеты зданий, промышленных конструкций, элементов сложных механизмов и многое другое.

Достигается это за счёт так называемого процесса «наращивания» объекта с использованием специальных компонентов по заранее подготовленной компьютерной 3D-модели.

В работе впервые на кафедре аэрогидродинамики СГАУ описывается применение технологии 3D-печати, для изготовления дренажной модели профиля крыла с механизацией. Данный метод изготовления моделей является более быстрым, точным и недорогим по